

APPENDIX 2-D – SUMMARY OF AMERICAN RIVER FLOW MANAGEMENT STANDARD

SUMMARY OF THE FLOW MANAGEMENT STANDARD PROGRAM

FOR THE LOWER AMERICAN RIVER

1.0 FLOW MANAGEMENT STANDARD DESCRIPTION

The Flow Management Standard (FMS) for the Lower American River includes provisions for: (1) minimum flow and water temperature requirements; (2) the lower American River Group (ARG) to play a consultative role in operational decisions; and (3) monitoring and evaluation to ascertain the biological and ecological status of the river, and to provide input into the river management process.

1.1 MINIMUM FLOW REQUIREMENTS

The Minimum Flow Requirements prescribe the minimum flows to be released from Nimbus Dam, and are the cornerstone of the FMS. The Minimum Flow Requirements do not preclude Reclamation from making higher releases at Nimbus Dam, and can vary throughout the year in response to the hydrology of the Sacramento and American river basins.

Minimum Release Requirements

The Minimum Release Requirements (MRR) range from 800 to 2,000 cfs based on a sequence of seasonal indices and adjustments. The minimum Nimbus Dam release requirement is determined by applying the appropriate water availability index (Index Flow). Three water availability indices (i.e., Four Reservoir Index (FRI), Sacramento River Index (SRI), and the Impaired Folsom Inflow Index (IFII)) are applied during different times of the year, which provides adaptive flexibility in response to changing hydrological and operational conditions.

During some months, Prescriptive Adjustments may be applied to the Index Flow, resulting in the MRR. If there is no Prescriptive Adjustment, the MRR is equal to the Index Flow.

Discretionary Adjustments for water conservation or fish protection may be applied during the period extending from June through October. If Discretionary Adjustments are applied, then the resultant flows are referred to as the Adjusted Minimum Release Requirement (Adjusted MRR).

The MRR and Adjusted MRR may be suspended in the event of extremely dry conditions, represented by “conference years” or “off-ramp criteria”. Conference years are defined when the projected March through November unimpaired inflow into Folsom Reservoir is less than 400,000 acre-feet. Off-ramp criteria are triggered if forecasted Folsom Reservoir storage at any time during the next twelve months is less than 200,000 acre-feet.

Water availability indices, Index Flows, Prescriptive Adjustments, MRRs, Discretionary Adjustments, and Adjusted MRRs are presented in **Table 1**.

Table 1. Flow Management Standard Indices and Flow Requirements

Month	Index	Index Flows (cfs)	Prescriptive Adjustments	Minimum Release Requirements (cfs)	Discretionary Adjustments	Adjusted Minimum Release Requirements (cfs)
October	FRI	800-1,500	NA	800-1,500	Fish Protection Adjustment	1,250- 1,499
November	FRI	800-2,000	Spawning Flow Progression	800-2,000	NA	
December	FRI	800-2,000	NA	800-2,000	NA	
January	SRI If Above Normal or Wet Year (SRI \geq 15.7 MAF) then release 1,750 cfs	1,750	December End-of-Month Storage Adjustment	800-1,750	NA	
	SRI If Dry or Below Normal Year (10.2 < SRI < 15.7 MAF) then maintain December MRR up to 1,750 cfs	800-1,750	When End-Of-December Storage is < 300 TAF, then January MRR is 85% of December MRR		NA	
	SRI If Critical Year (SRI < 10.2 MAF) then reduce MRR	85% of December MRR, but not less than 800	NA		NA	
February	SRI If Above Normal or Wet Year (SRI \geq 15.7 MAF) then release 1,750 cfs	1,750	January End-of-Month Storage Adjustment	800-1,750	NA	
	SRI If Dry or Below Normal Year (10.2 < SRI < 15.7 MAF) then maintain January MRR up to 1,750 cfs	800-1,750	When End-Of-January Storage is < 350 TAF, then February MRR is 85% of January MRR		NA	
	SRI If Critical Year (SRI < 10.2 MAF) then reduce MRR	85% of January MRR, but not less than 800	NA		NA	
March through May	IFII	800-1,750	May End-of-Month Storage Adjustment When Calculated End-Of-May storage is < 700 TAF, then IFII Index Flow or February MRR, whichever is less	800-1,750	NA	
June though Labor Day	IFII	800-1,750	September End-of-Month Storage Adjustment When Calculated End-Of-September storage is < 300 TAF, then IFII Index Flow or Calculated Storage-Based Flow, whichever is less	800-1,750	Water Conservation or Fish Protection Adjustment	1,500-1,749
Post-Labor Day through September 30	IFII	June through Labor Day MRR, but not more than	NA	800-1,500	Fish Protection Adjustment	1,250-1,499

Table 1. Flow Management Standard Indices and Flow Requirements

Month	Index	Index Flows (cfs)	Prescriptive Adjustments	Minimum Release Requirements (cfs)	Discretionary Adjustments	Adjusted Minimum Release Requirements (cfs)
		1,500				

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Water Availability Indices and Other Definitions

Four Reservoir Index

The FRI is an index of the end-of-September combined carryover storage in Folsom, French Meadows, Hell Hole, and Union Valley reservoirs and is used to calculate the Index Flow for October through December.

Sacramento River Index

The SRI is an index of forecasted water year runoff for the Sacramento River Basin, and is used to calculate the Index Flow for the months of January and February.

Impaired Folsom Inflow Index

The IFII is an index of the forecasted volume of flow into Folsom Reservoir from May through September, and is used to calculate the Index Flow from March through September.

Index Flows

Index Flows are the initial flows (nominal flows) identified by application of the various water availability indices, and are subject to Prescriptive and Discretionary Adjustments, which result in Minimum Release Requirements (defined below). Year-round water availability indices and corresponding Index Flows are presented in **Figure 2**. The October 1 through December 31 Index Flows range between 800 and 2,000 cfs. The January 1 through Labor Day Index Flows range between 800 and 1,750 cfs. The post-Labor Day through September 30 Index Flows range between 800 and 1,500 cfs.

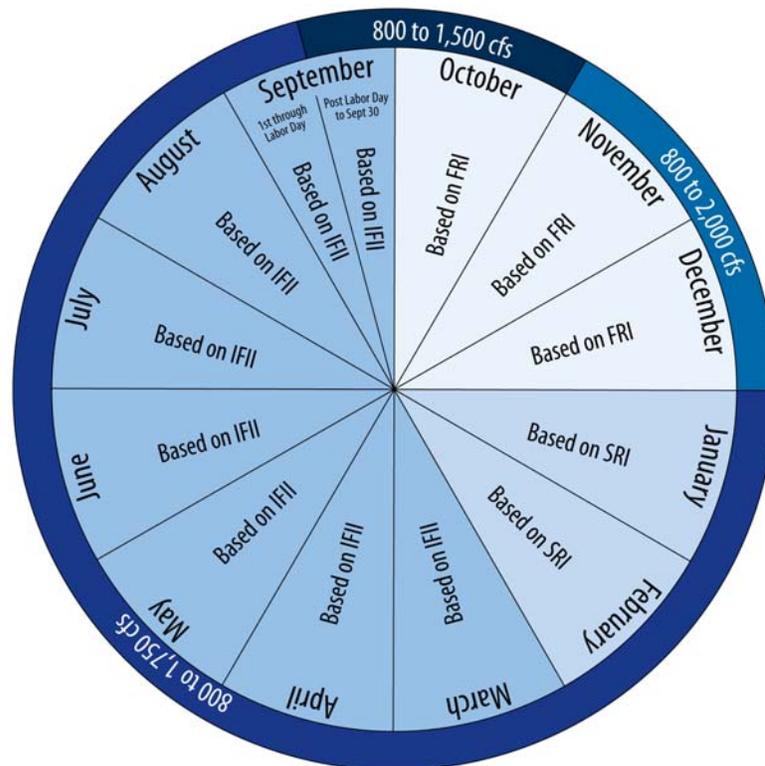


Figure 2. Index Flow Requirements

Prescriptive Adjustments

The FMS includes five Prescriptive (non-discretionary) Adjustments to the Index Flows in consideration of Folsom Reservoir storage and water conservation.

- Chinook Salmon Spawning Flow Progression Adjustment
- December End-of-Month Storage Adjustment
- January End-of-Month Storage Adjustment
- May End-of-Month Storage Adjustment
- September End-of-Month Storage Adjustment

When Prescriptive Adjustments are applicable, the MRR is equal to the value that results from applying the given adjustment to the Index Flow. When Prescriptive Adjustments are not applicable, the MRR is equal to the Index Flow.

Discretionary Adjustments

Two types of discretionary adjustments are possible: (1) water conservation; and (2) fish protection. A water conservation Discretionary Adjustment may be implemented in consideration of Folsom Reservoir storage, but will not be permitted if it would be likely to cause or exacerbate harmful water temperature-related impacts to rearing juvenile steelhead or spawning fall-run Chinook salmon. Fish protection includes conservation of remaining cold water reserves, taking into account effects of the Discretionary Adjustment on in-river water temperature and habitat.

Overview of the Coldwater Pool Management Model and the Automated Temperature Selection Procedure

Coldwater Pool Management Model

Flexibility to meet the Flow Management Standard (FMS) water temperature objectives may be promoted by using the Coldwater Pool Management Model (CPMM) in the development and updating of the Annual Water Temperature Management Plan. The CPMM may be used to select the most beneficial seasonal target temperature objectives for the lower American River during a given year. Selection of seasonal water temperatures is:

- Characterized by the rate and duration with which available cold water will be released from Folsom Reservoir to control water temperatures
- Based on the biological benefit expected from controlling lower American River water temperatures
- Limited by the amount of cold water available in Folsom Reservoir.

The CPMM requires:

- Initial reservoir conditions (i.e., profiles of water temperature, total dissolved solids, and suspended solids)
- Hydrologic time series data of projected North and South Forks of the American River inflow to Folsom Reservoir
- Reservoir evaporation and river heat gain
- Meteorological data
- Folsom Reservoir operation data (Folsom Dam releases and Folsom Pumping Plant diversion)

Automated Temperature Selection Procedure

The Folsom Reservoir and lower American River water temperature models are utilized in an iterative manner referred to as the Automated Temperature Selection Procedure (ATSP). The ATSP operates the reservoir and river water temperature models with the objective of achieving monthly target water temperatures in the lower American River at Watt Avenue, and is designed to aid in the planning and achievement of general management objectives for the lower American River.

Seasonal Priorities/Automated Temperature Selection Procedure Schedules

The ATSP involves the use of multiple target water temperature schedules for the lower American River at Watt Avenue. The “schedule” approach was developed with the purpose of balancing the seasonal use of Folsom Reservoir’s coldwater availability, which varies from year to year. The prioritization order of the target temperature schedules for the FMS reflects the desire to protect juvenile steelhead over-summer rearing while balancing the needs of fall-run Chinook salmon spawning, given the constraints of coldwater pool availability at Folsom Reservoir.

A schedule of water temperatures, for May through November, is specified as the preferred schedule of monthly water temperature targets. Because Folsom Reservoir water temperatures are not isothermal during the May through November period, ATSP water temperature targets are achieved through choice of reservoir level from which releases are drawn. If the preferred schedule cannot be achieved with the available release level choices, the procedure cycles to a second, slightly less preferred schedule of water temperatures. If the second schedule cannot be met, the procedure continues through a series of schedules, arranged by declining preference, until a schedule of targets is met for that year.

Table 1 presents the ATSP schedule developed with the purpose of balancing the seasonal use of Folsom Reservoir’s coldwater availability prioritized to protect juvenile steelhead over-summer rearing while balancing the needs of fall-run Chinook salmon spawning. If desirable, an alternative schedule could be developed. Schedule #1 has the most beneficial application of coldwater for conditions when sufficient coldwater is available for Folsom Reservoir releases during the May through November period. Schedule #78 has the least desirable application for fisheries benefits relative to other schedules, but may be the only achievable schedule during years of extremely limited coldwater pool availability in Folsom Reservoir. The monthly May through November targets are varied incrementally, to reduce and shift the amount of coldwater released during the summer months, to achieve the balanced management objectives for steelhead and fall-run Chinook salmon. In Table 1, the cells highlighted in yellow indicate changes in water temperature targets for a given month and schedule, as compared to the previous schedule.

There are no water temperature targets for the months of December through April. During these months of the year, Folsom Reservoir is typically well-mixed and the water column is nearly isothermal with depth. For this reason and because ambient air temperatures are sufficient to maintain suitable water temperatures for steelhead and fall-run Chinook salmon in the lower American River, water temperature targets are not identified for the December through April period.

Table 1. Automated Temperature Selection Procedure Schedules.

Schedule	Lower American River Water Temperature Targets at Watt Avenue (°F)						
	May	Jun	Jul	Aug	Sep	Oct	Nov
1	63	63	63	63	63	56	56
2	63	63	63	63	63	57	56
3	63	63	63	63	63	58	56
4	63	63	63	63	63	59	56
5	63	63	63	63	63	60	56
6	63	63	63	63	63	60	57
7	63	63	63	63	63	60	58
8	63	63	64	63	63	60	58
9	63	63	64	64	63	60	58
10	63	63	64	64	64	60	58
11	63	64	64	64	64	60	58
12	64	64	64	64	64	60	58
13	64	64	65	64	64	60	58
14	64	64	65	65	64	60	58
15	64	64	65	65	65	60	58
16	64	65	65	65	65	60	58
17	65	65	65	65	65	60	58
18	65	65	65	65	65	61	58

Schedule	Lower American River Water Temperature Targets at Watt Avenue (°F)						
	May	Jun	Jul	Aug	Sep	Oct	Nov
19	65	65	65	65	65	62	58
20	65	65	65	65	65	63	58
21	65	65	65	65	65	64	58
22	65	65	65	65	65	65	58
23	65	65	65	65	65	65	59
24	65	65	66	65	65	65	59
25	65	65	66	66	65	65	59
26	65	65	66	66	66	65	59
27	65	66	66	66	66	65	59
28	66	66	66	66	66	65	59
29	66	66	67	66	66	65	59
30	66	66	67	67	66	65	59
31	66	66	67	67	67	65	59
32	66	67	67	67	67	65	59
33	67	67	67	67	67	65	59
34	67	67	68	67	67	65	59
35	67	67	68	68	67	65	59
36	67	67	68	68	68	65	59
37	67	68	68	68	68	65	59
38	68	68	68	68	68	65	59
39	68	68	68	68	68	66	59
40	68	68	68	68	68	67	59
41	68	68	68	68	68	68	59
42	68	68	69	68	68	68	59

Schedule	Lower American River Water Temperature Targets at Watt Avenue (°F)						
	May	Jun	Jul	Aug	Sep	Oct	Nov
43	68	68	69	69	68	68	59
44	68	68	69	69	69	68	59
45	68	69	69	69	69	68	59
46	69	69	69	69	69	68	59
47	69	69	69	69	69	69	59
48	69	69	69	69	69	69	60
49	69	69	70	69	69	69	60
50	69	69	70	70	69	69	60
51	69	69	70	70	70	69	60
52	69	70	70	70	70	69	60
53	70	70	70	70	70	69	60
54	70	70	70	70	70	70	60
55	70	70	70	70	70	70	61
56	70	70	71	70	70	70	61
57	70	70	71	71	70	70	61
58	70	70	71	71	71	70	61
59	70	71	71	71	71	70	61
60	71	71	71	71	71	70	61
61	71	71	71	71	71	71	61
62	71	71	71	71	71	71	62
63	71	71	72	71	71	71	62
64	71	71	72	72	71	71	62
65	71	71	72	72	72	71	62
66	71	72	72	72	72	71	62

Schedule	Lower American River Water Temperature Targets at Watt Avenue (°F)						
	May	Jun	Jul	Aug	Sep	Oct	Nov
67	72	72	72	72	72	71	62
68	72	72	72	72	72	72	62
69	72	72	72	72	72	72	63
70	72	72	72	72	72	72	64
71	72	72	72	72	72	72	65
72	72	72	72	72	72	72	66
73	72	72	72	72	72	72	67
74	72	72	72	72	72	72	68
75	72	72	72	72	72	72	69
76	72	72	72	72	72	72	70
77	72	72	72	72	72	72	71
78	72	72	72	72	72	72	72